VI. How Clean Is Surface Water in Arizona?

This chapter provides a statewide overview of the 2004 assessment. It is a summary of the individual surface water assessments provided in Chapter IV and V. These statistics are used by EPA in its published reports to Congress on the quality of water in the United States. The discussion and graphics in this section cannot be used to infer water quality in surface waters not assessed nor water on tribal lands in Arizona.

Water Quality in Streams, Canals, and Washes

For this assessment, 3,450 miles of streams, canals, and washes were assessed. **Figure 27** below illustrates the overall stream assessments by category (note that Category 2, "attaining some uses" and Category 3, "inconclusive" from Chapter V have been combined as "inconclusive"). It should be noted that the number of streams assessed is a small percentage of the approximately 90,375 miles of streams in Arizona; however, it includes 77% of the state's perennial stream miles (2,721 of the estimated 3,530 perennial miles). The primary goal of ADEQ's Ambient Monitoring Program is to monitor and assess all of Arizona's perennial stream miles and the majority of those with extended intermittent flow. Streams with ephemeral flow (flow only in direct response to precipitation) are a challenge to monitor and take much more time for a full assessment to be made.

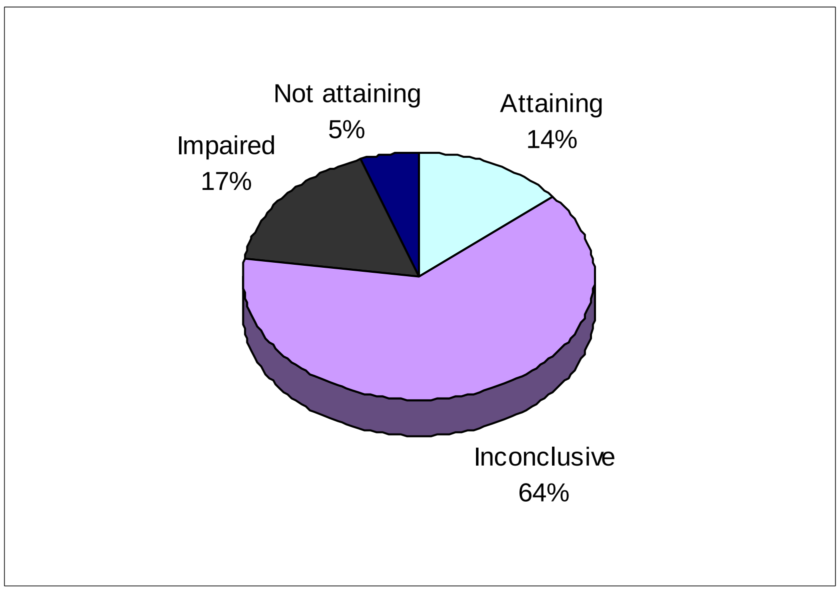


Figure 27. Overall use support - streams

As illustrated **Figure 28** below, relative use support is fairly consistent among all designated uses with the exception of Aquatic and Wildlife uses. For the fish consumption, body contact, domestic water source, and agricultural uses, approximately 40 - 60% are attaining the use, 40 - 60% are inconclusive and in need of further monitoring, and 5% or less are impaired or not attaining.

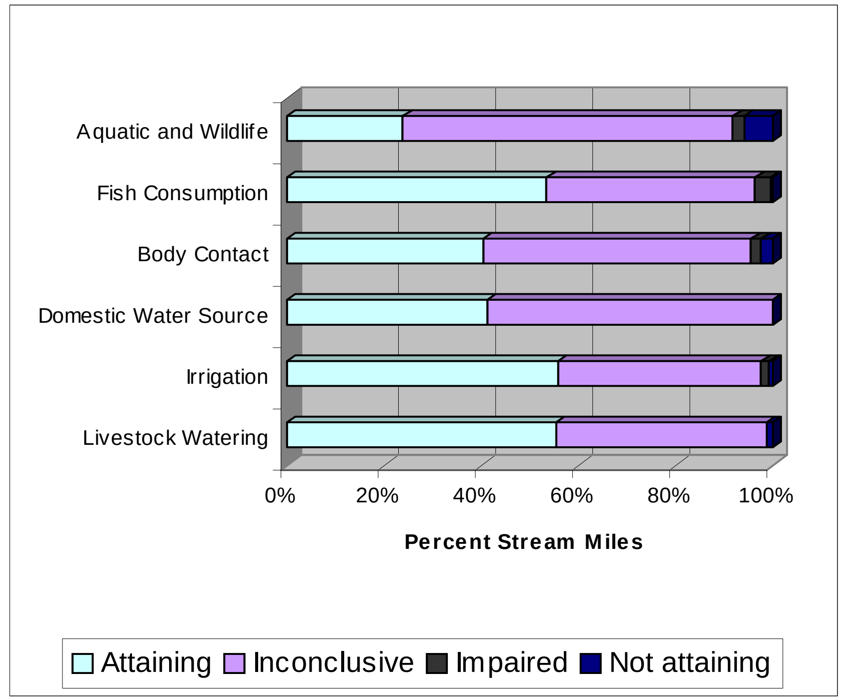


Figure 28. Support by designated use – streams

For the Aquatic and Wildlife designated uses, approximately 25% of the streams assessed are attaining, 60% inconclusive, and 15% impaired and not attaining. Overall, there are fewer streams attaining the use than in 2002. There are a couple of reasons for this change. This assessment was the first in which ADEQ made 303(d) listings for chronic A&W standards using the Impaired Water Identification Rule. Chronic standards are much more stringent than the acute standards. Acute standards are set higher to address short-term, usually lethal effects, while chronic standards are set lower to protect against long-term effects (such as reduced growth, survival and reproduction).

Additionally, because chronic standards are so much lower, it was often the case that laboratory analyses did not produce detection limits low enough to assess chronic standards (detection limit was higher than the standard), resulting in an assessment of "inconclusive."

Table 33. Use Support Summary – Streams Assessed in 2004

Designated Uses	Attaining (miles)	Inconclusive (miles)	Impaired (miles)	Not Attaining (miles)	Total Assessed (miles)
Overall Use Support	**480**	**2,186**	**601**	**183**	**3,450**
Aquatic and Wildlife	715	2,023	470	171	3,378
Fish Consumption	1,669	1,340	99	12	3,119
Body Contact	1,366	1,865	70	77	3,378
Domestic Water Source	257	367	0	0	624
Irrigation	1,061	799	34	11	1,904
Livestock Watering	1,662	1,309	3	35	3,006

This reach of the Agua Fria River, near Cordes Junction, Arizona, is attaining all of its designated uses.

An ADEQ staff member takes flow measurements on the Little Colorado River, near Springerville, Arizona. This reach is not attaining its uses due to turbidity exceedances. A TMDL has already been completed.

Water Quality in Lakes and Reservoirs

Of approximately 168,800 acres of perennial lakes or reservoirs in Arizona (not on Indian lands), 76,425 were assessed. The relative distribution of lake assessments by category is illustrated in **Figure 29** below. ADEQ's goal is to assess all perennial, publicly-owned lakes over the next two watershed cycles.

Of the lake acres assessed, approximately 94% were inconclusive and 6% impaired or not attaining. "Attaining" acres constitute only 220 (one lake) of the approximately 76,425 acres assessed, which is less than 1%. This percentage is rounded to "0%" in the graphic below. Many of the "inconclusive" lakes were simply lacking sufficient data to make a full assessment.

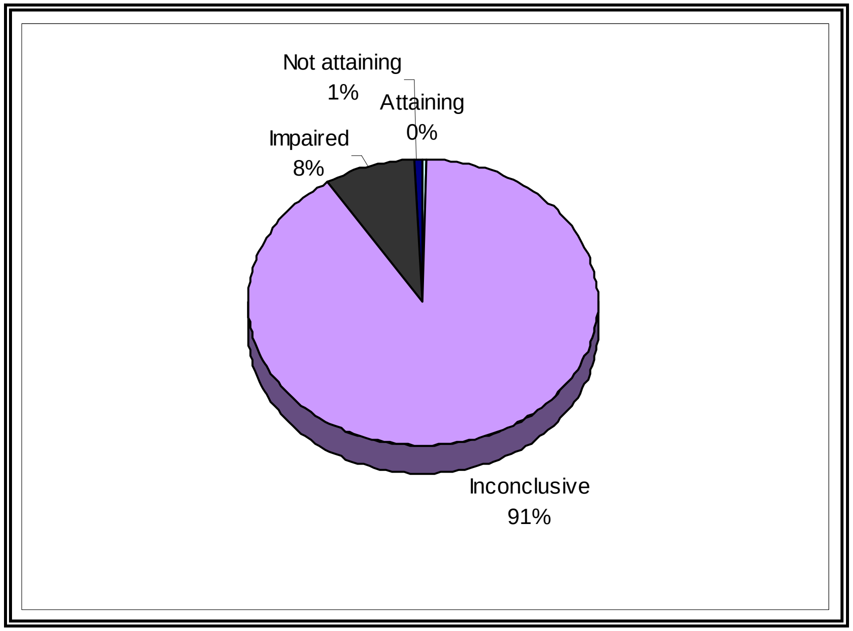


Figure 29. Overall use support - lakes

As illustrated in **Figure 30** below, the relative use support in lakes is consistent among Fish Consumption, Domestic Water Source, Irrigation, and Livestock Watering, with about 60% attaining, 30-40% inconclusive, and less than 5% impaired or not attaining. A larger percentage of lakes acres are inconclusive for the Aquatic and Wildlife use, mostly due to application of chronic standards, and a lot more "not attaining," due to a number of nutrient TMDLs completed that addressed the A&W use. The large percentage of inconclusive lake acres for the Body Contact uses (Full and Partial) is mostly due to a lack of *Escherichia coli* data needed to make an assessment.

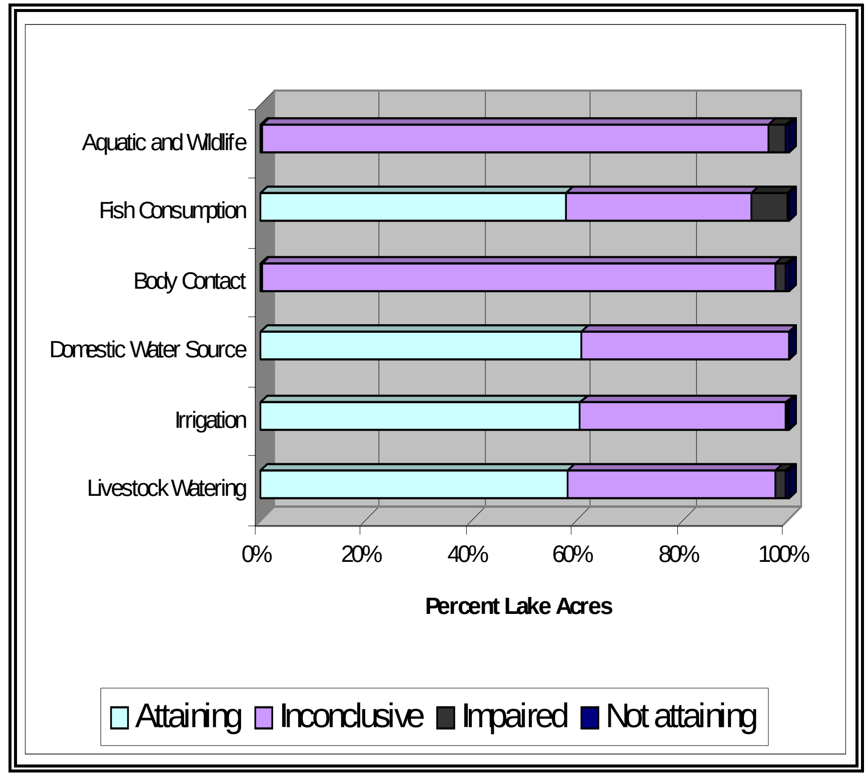
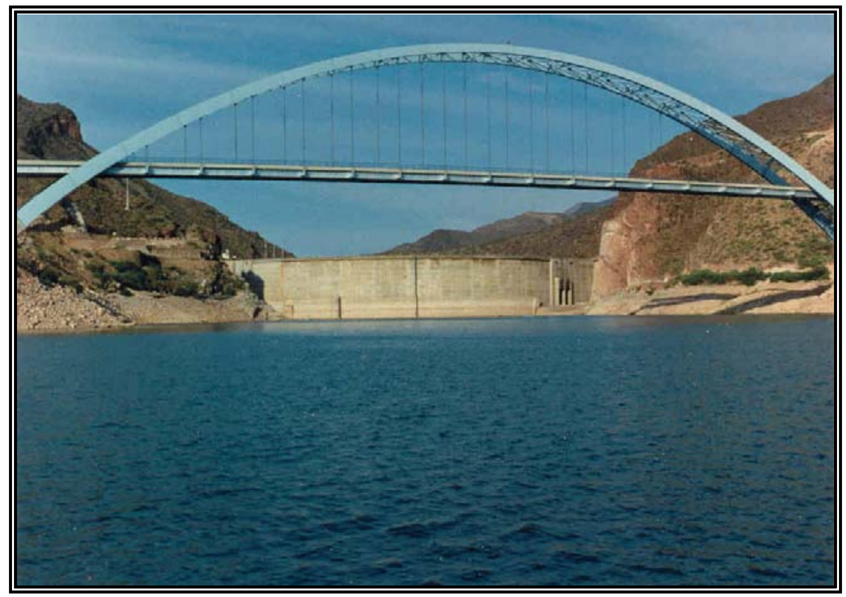


Figure 30. Support by designated use – lakes

Table 34. Use Support Summary – Lakes Assessed in 2004

Designated Uses	Attaining (acres)	Inconclusive (acres)	Impaired (acres)	Not Attaining (acres)	Total Assessed (acres)
Overall Use Support	**220**	**69,458**	**6,362**	**615**	**76,655**
Aquatic and Wildlife	245	73,451	2,602	356	76,655
Fish Consumption	44,331	26,836	5,319	169	76,655
Body Contact	220	74,500	1,579	355	76,655
Domestic Water Source	40,692	26,319	0	0	67,011
Irrigation	43,725	28,028	152	235	72,140
Livestock Watering	43,869	29,748	1,564	355	75,536

Peña Blanca Lake in southern Arizona is not attaining its uses. A TMDL for mercury in fish tissue was completed in 1999, and a fish consumption advisory is still in effect.



Roosevelt Lake, northeast of Phoenix, was impacted by the Rodeo-Chediski fire of 2002. Numerous violations of water quality standards occurred immediately following the fire. The status of this lake is inconclusive until more data are gathered to determine whether residual effects from the fire still remain.

What pollutants impair lakes and streams?

Pollutants identified in this assessment are summarized in **Tables 35 and 36** and compared in **Figures 31 and 32** below. Information about pollutants impairing a specific lake or stream is provided in Chapter IV. General information about these pollutants and their sources follows below.

Table 35. Pollutants Impairing Arizona's Streams – 2004

	Impaired or Not Attaining (miles)
Metals/Metalloids	
Arsenic	3
Boron	33.6
Cadmium	56
Copper	214.7
Lead	21
Mercury	34.6
Selenium	203.9
Silver	17.4
Zinc	78.9
any metal	**663.1**
Sediment-related	216.1
Pathogens	
Escherichia coli	99.1
Pesticides	
Chlordane	98.9
DDT	98.9
Toxaphene	98.9
Low pH	44
Nutrients	
Nitrogen/Nitrate	32.1
Ammonia	6.2
Low Dissolved Oxygen	31.6
Chlorine	6.2

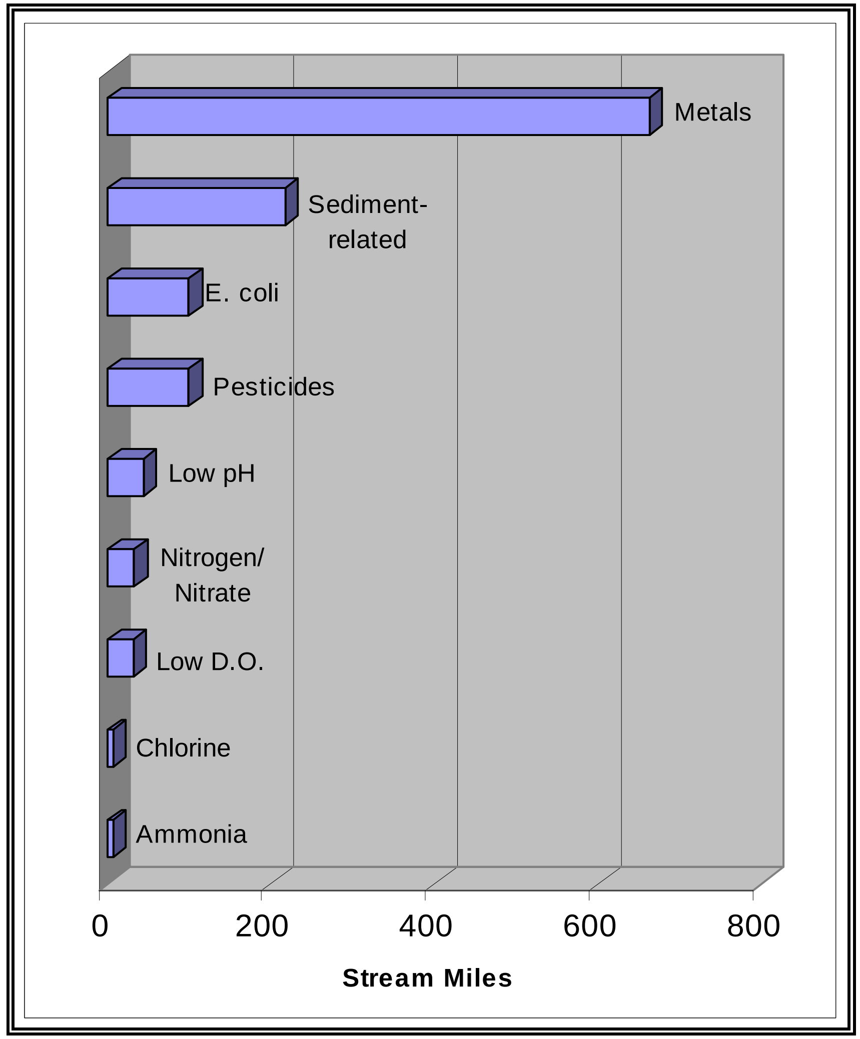


Figure 31. Pollutants impairing streams

Table 36. Pollutants Impairing Arizona's Lakes

	Impaired or Not Attaining (acres)
Metals	
Mercury	5,333
Nutrient-related (impaired by any of the following: pH, dissolved oxygen, nitrogen, ammonia, chlorophyll)	2,958
Pesticides	
Chlordane	285
DDT	285
Toxaphene	285
Pathogens	
Escherichia coli	13

Metals – Metals can leach more readily from soil or mineralized rock that has been exposed by mining, road building or land development activities. Ore bodies can also naturally contribute metals to streams and ground water springs recharging streams. Arizona has extensive areas of mineralized rock, and therefore, a high potential for metals pollution. Generally, metals (e.g., beryllium, cadmium, copper, manganese, mercury, silver, and zinc) rapidly adhere to sediment, with the more toxic dissolved metals being present in surface water only for relatively short distances near mining sites or other potential sources. When metal-contaminated sediment is transported downstream to a lake, the water slows and the sediments drop to the bottom of the lake. Metals do not readily go back into a dissolved state in these relatively alkaline lakes, and the contamination is buried under layers of sedimentation. Therefore we do not often see metals pollution in lakes, with the exception of mercury.

Once elemental mercury is methylated by microbes in the bottom of the lake, methylmercury can then bioaccumulate in aquatic life. The concentration of mercury then biomagnifies (compounds) as contaminated tissue is consumed in the food chain. This also means that mercury can occur well below the detection limit in surface water samples and even in the sediment, while fish tissue can be contaminated through bioaccumulation to a level that is hazardous for human consumption or for wildlife that prey on these fish.

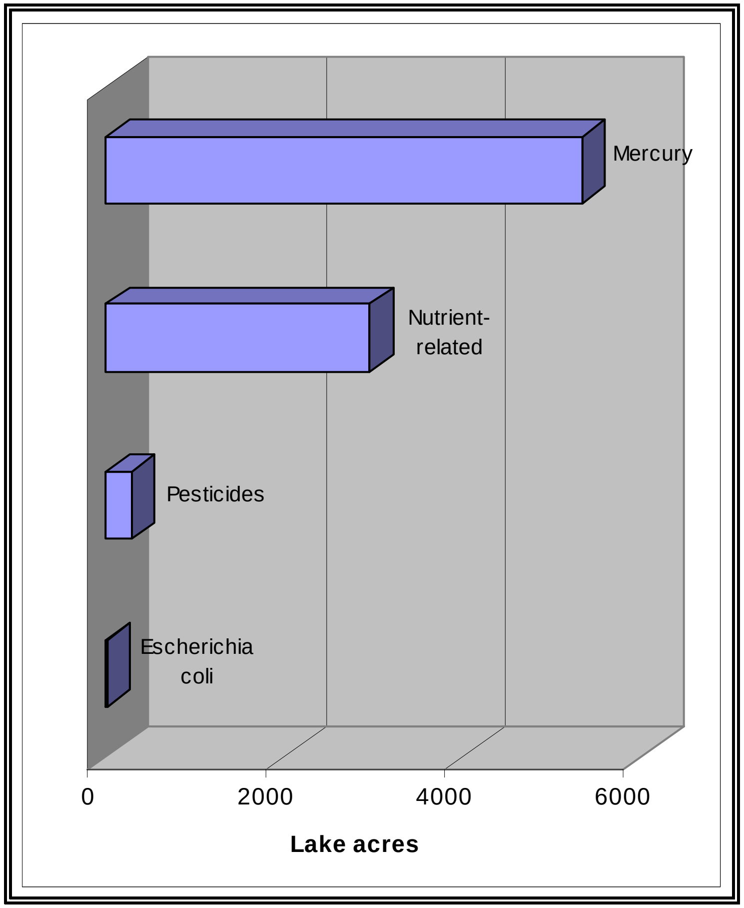


Figure 32. Pollutants impairing lakes

Low Dissolved Oxygen, High pH and High Nutrient Levels – Varying combinations of these factors occur in many of Arizona's shallow, constructed lakes, and in streams as well, although less often. Low dissolved oxygen and high pH stress aquatic organisms and can contribute to fish kills. A high density of submerged and emergent aquatic vegetation can restrict recreational activities. In addition, algal blooms which can result from increased nutrients use a substantial amount of oxygen in the water at night when photosynthesis cannot take place.

ADEQ staff members practice "clean-sampling" techniques on Alamo Lake in the Bill Williams watershed. Clean sampling techniques should allow ADEQ to achieve lower laboratory detection limits for mercury. Alamo Lake is on the 2004 303(d) List due to mercury in fish tissue, ammonia and pH. A fish consumption advisory was issued in February 2004.

Pathogens – ADEQ measures pathogen level s by testing for *Escherichia coli*. While some amount of pathogens occurs naturally in the environment, they can sometimes reach dangerously high levels and pose a threat to human health. Some swimming areas regularly close to the public when this happens.

Pesticides – Most of the pesticides found in Arizona's surface waters are now banned from use in the United States. However, these substances take a long time to degrade and are still a problem today. They often are present in bottom sediment, where they can bioaccumulate up the food chain to fish and fish predators, including humans.

Turbidity and Suspended Sediment Concentration (SSC) – Arizona repealed its turbidity standard in 2002 and adopted a suspended sediment concentration standard to protect Aquatic and Wildlife designated uses. Turbidity is a qualitative measure of water clarity or opacity, while suspended sediment concentration is a quantitative measure of suspended solids. These two parameters represent two different ways to measure fine suspended particles such as clay, silt, organic and inorganic matter, plankton, and other microscopic organisms.

Arizona's turbidity standard was derived from criteria established in more humid states that do not share its unique arid conditions, relatively low plant coverage, and erodible soils. These factors make some degree of suspended solids a natural phenomenon in Arizona; however, there are numerous other human-induced causes that have raised suspended sediment loads to an unhealthy level in some of Arizona's lakes and streams. Excessive suspended solids may be associated with aquatic habitat degradation such as reduced light penetration, temperature changes, excessive bottom deposits, and algal blooms.

Arizona's new numeric suspended sediment concentration criterion is intended to protect fish in streams, with the exception of effluent-dominated streams. It is also not applicable to lakes. Arizona's SSC standard is set at 80 mg/L, expressed as the geometric mean of at least four samples. The new standard is only applicable to samples collected at or near base flow and does not apply to a surface water during or soon after a precipitation event.

Since the SSC standard was just recently adopted in 2002, a minimal amount of data were available for this assessment. Thus, ADEQ has continued to assess the turbidity standard repealed in 2002 in an effort to record potential suspended sediment problems. Additionally, these exceedances provide evidence of a potential narrative bottom deposits standard violation.

Table 37 on the next page provides a checklist of those waters with significant turbidity and/or SSC exceedances. These lakes and streams will be prioritized for further suspended sediment and bottom deposit studies.

Table 37. Surface waters with significant turbidity and/or SSC exceedances

	Parameter	Suspended Sediment Concentration		Turbidity		
Waterbody	Waterbody ID	Impaired due to SSC*	Inconclusive due to SSC	On the 2002 303(d) List for turbidity	Significant number of turbidity exceedances (would have been listed by ADEQ or EPA under repealed standard)	Turbidity TMDL complete (not attaining)
Bill Williams Watershed - (none)						
Colorado - Grand Canyon Watershed						
Colorado River, Parashant Canyon - Diamond Creek	AZ15010002-003	X		X	X	
Dogtown Reservoir	AZL15010004-0480				X	
Paria River, Utah border - Colorado River	AZ14070007-123	X			X	
Virgin River, Beaver Dam Wash - Big Bend Wash	AZ15010010-003	X		X	X	
Colorado - Lower Gila Watershed						
Colorado River, Indian Wash - Imperial Dam	AZ15030104-001		X			
Colorado River, Main Canal - Mexico border	AZ15030107-001		X			
Little Colorado Watershed						
Ashurst Lake	AZL15020015-0090				X	
Billy Creek, headwaters - Show Low Creek	AZ15020005-019				X	
Chevelon Creek, Black Canyon - Little Colorado River	AZ15020010-001				X	
Kinnikinick Lake	AZL15020015-0730				X	
Little Colorado River, West Fork - Water Canyon Creek	AZ15020001-011				X	X
Little Colorado River, Water Canyon Creek - Nutrioso Creek	AZ15020001-010				X	X
Little Colorado River, Nutrioso Creek - Carnero Wash	AZ15020001-009				X	X
Little Colorado River, unnamed trib (15020001-021) - Lyman Lake	AZ15020001-005				X	X
Little Colorado River, Silver Creek - Carr Wash	AZ15020002-004				X	
Little Colorado River, Zion Reservoir - Concho Creek	AZ15020002-016		X			
Little Colorado River, Porter Tank - McDonalds Wash	AZ15020008-017	X				
Nutrioso Creek, headwaters - Picnic Creek	AZ15020001-017					X
Nutrioso Creek, Picnic Creek - Little Colorado River	AZ15020001-015					X
Show Low Creek, headwaters - Linden Wash	AZ15020005-012				X	

	Parameter	Suspended Sediment Concentration		Turbidity		
Waterbody	Waterbody ID	Impaired due to SSC*	Inconclusive due to SSC	On the 2002 303(d) List for turbidity	Significant number of turbidity exceedances (would have been listed by ADEQ or EPA under repealed standard)	Turbidity TMDL complete (not attaining)
Middle Gila Watershed						
Gila River, Centennial Wash - Gillespie Dam	AZ15070101-008			X	X	
Salt River Watershed						
Christopher Creek, headwaters - Tonto Creek	AZ15060105-353			X	X	
Roosevelt Lake	AZL15060103-1240				X	
Salt River, Pinal Creek - Roosevelt Lake	AZ15060103-004		X			
Tonto Creek, headwaters - unnamed trib at 3418'10"/111 04'14"	AZ15060105-013A			X	X	
Tonto Creek, unnamed trib at 3418'10"/111 04'14" - Haigler Creek	AZ15060105-013B			X	X	
San Pedro Watershed - (none)						
Santa Cruz Watershed						
Lakeside Lake	AZL15050302-0760				X	
Nogales and East Nogales Washes	AZ15050301-011			X	X	
Santa Cruz River, Josephine River - Tubac bridge	AZ15050301-008A			X	X	
Upper Gila Watershed						
Gila River, San Francisco River - Eagle Creek	AZ15040005-024				X	
Gila River, Eagle Creek - Bonita Creek	AZ15040005-023				X	
Gila River, Bonita Creek - Yuma Wash	AZ15040005-022		X	X	X	
San Francisco River, headwaters - New Mexico border	AZ15040004-023				X	
San Francisco River, Limestone Gulch - Gila River	AZ15040004-001			X	X	
Verde Watershed						
Beaver Creek, Dry Beaver Creek - Verde River	AZ15060202-002			X	X	
Verde River, Oak Creek - Beaver Creek	AZ15060202-015					X
Verde River, Beaver Creek - HUC boundary 15060203	AZ15060202-001					X
Verde River, West Clear Creek - Fossil Creek	AZ15060203-025				X	X
Verde River, Tangle Creek - Ister Flat	AZ15060203-018				X	

	Parameter	Suspended Sediment Concentration		Turbidity		
Waterbody	Waterbody ID	Impaired due to SSC*	Inconclusive due to SSC	On the 2002 303(d) List for turbidity	Significant number of turbidity exceedances (would have been listed by ADEQ or EPA under repealed standard)	Turbidity TMDL complete (not attaining)
Whitehorse Lake	AZL15060202-1630				X	

* Note that SSC data were not available for most waters

The high suspended sediment levels are evident in the murky brown water of the Little Colorado River near Woodruff, Arizona. This reach of the Little Colorado, from Silver Creek to Carr Wash, is on the Planning List due to exceedances of the former turbidity standard.

An ADEQ staff member conducts sampling at a gage station specially constructed for a sediment study. The gage is located on the West Fork of the Black River in eastern Arizona. Data from this study were not yet available for this assessment.

What are the major sources of these pollutants?

The probable sources of pollutants impairing water quality in Arizona are reported in **Tables 38 and 39** and compared in **Figures 33 and 34** below. It is important to note that <u>more than one source</u> may be impacting a given stream reach or lake. Also important to note is that for most streams and lakes, only a <u>potential, unconfirmed source</u> can be identified based on best available information, knowledge of land uses and activities, and geology of the watershed. Documented source identification is limited to locations where special investigations, such as a TMDL analysis, have been conducted.

Table 38. Probable Sources of Stream Pollutants

	Impaired or Not Attaining (miles)
Agriculture	
Grazing	205.8
Historic pesticides	98.9
Crop production	33.6
Mining	228.2
Hydrologic modification	181.6
Outside Arizona	124.1
Recreation	77.7
Roads	38.6
Atmospheric deposition	34.6
Septic systems	31.5
Point source	22.6
Waste disposal	15.5

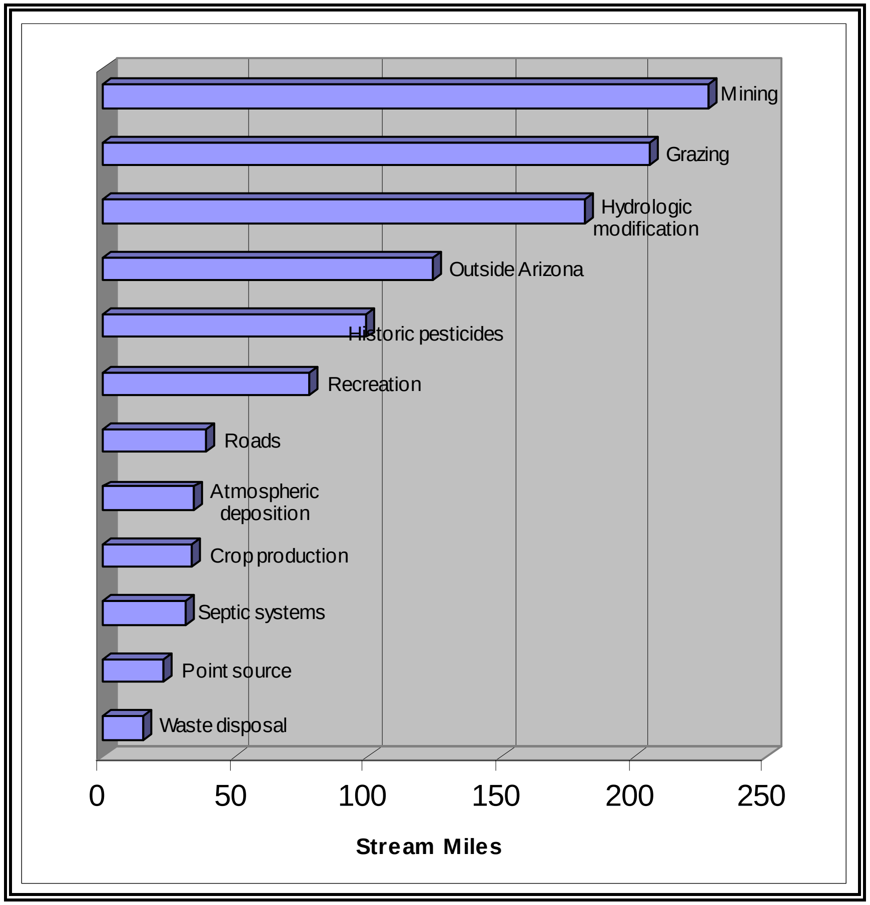


Figure 33. Probable sources of pollutants in streams

Table 39. Probable Sources of Lake Pollutants

	Impaired or Not Attaining (acres)
Atmospheric deposition	3,919
Nutrient cycling	2,773
Mining	1,464
Agriculture Historic pesticides Grazing	 285 230
Septic systems	355
Recreation	230
Design/Maintenance	215
Urban Area	112
Point Source	15

Natural Contributions -- Pollution is defined in the Clean Water Act, section 502 as a manmade or human-induced alteration of the chemical, physical, biological, and radiological integrity of water. Therefore, high levels of a pollutant which occur solely due to natural conditions are not a violation of Arizona's surface water quality standards because of a "natural background" exemption in the standards.

Natural sources do, however, make some relative contribution to almost all impaired waters. For example, copper is a naturally occurring substance in Arizona, but mining can disturb the earth and release unnaturally high amounts of copper into streams. Arizona's soils are highly erodible and have the potential to contribute suspended sediment easily, but grazing can add even more sediment to a stream. In addition, sunny and arid conditions can lead to excessive algal productivity and eutrophic lake conditions such as low dissolved oxygen and high pH, but poor lake design or maintenance can make these conditions much worse.

Because natural sources contribute to almost all impairments, it is not shown as a source category in Figure 33 or 34. These graphs illustrate suspected sources which add further pollution in addition to concentrations already occurring in the environment. Determining the relative contribution of natural sources among other potential sources may require sophisticated analysis requiring large amounts of data. This level of detailed analysis is conducted for a TMDL, use

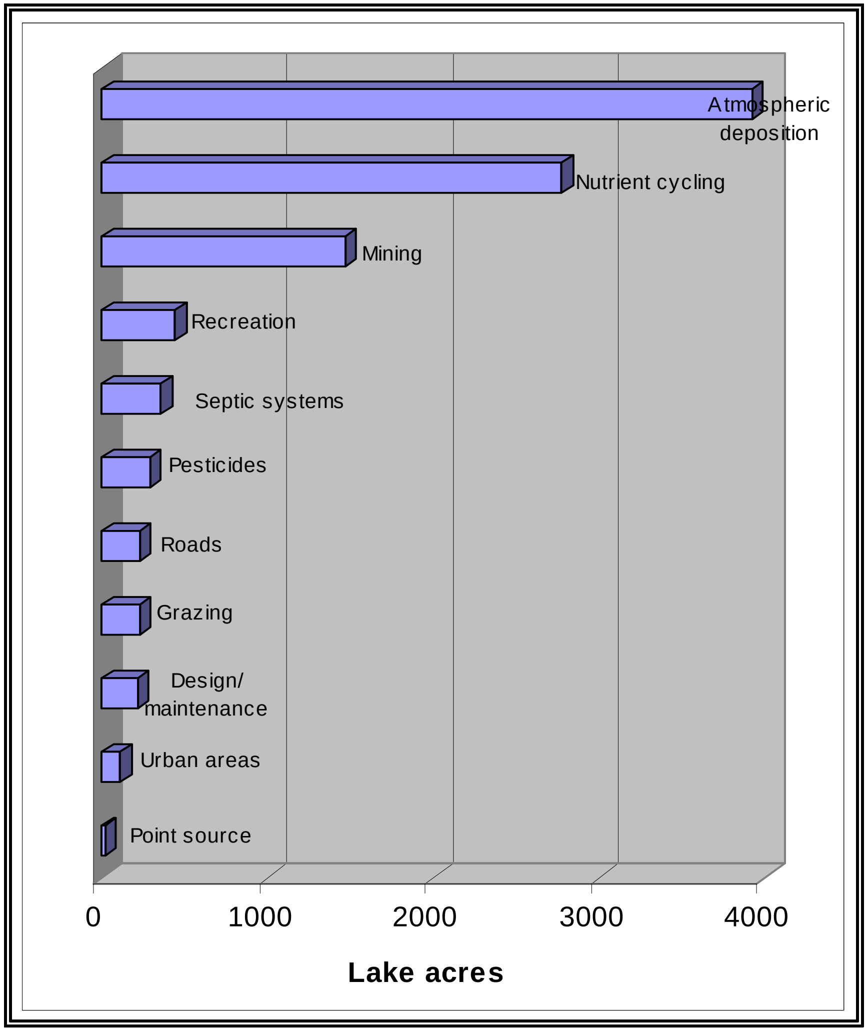


Figure 34. Probable sources of lake pollutants

attainability analysis, or to develop a site-specific standard.

Mining – Resource extraction activities and the natural occurrence of ores are frequently the source of metals and low pH in Arizona's streams. Mining occurs in Arizona because metal ores are present.

Nutrient Cycling – Although normal for a lake system, nutrient cycling may cause nutrient over-enrichment and hypereutrophic conditions, which can in turn result in low dissolved oxygen levels and fish kills. Nutrient cycling can be exacerbated by excessive nutrient loading from sources such as agriculture or septic systems.

Shallow Lake Design and Maintenance – The construction and maintenance of a relatively shallow lake can result in negative impacts to the water chemistry or biological community. The physical characteristics of the lake (depth, volume, flushing rate) need to be in balance with natural rates of sediment transport and trophic conditions. When a lake or reservoir routinely exceeds narrative or numeric standards, redesigning the lake or changing maintenance procedures may be necessary to alleviate the water quality problems.

Agriculture -- Agricultural sources can be broadly grouped into four areas of concern: crop production, grazing, concentrated animal feeding operations, and historic use of banned pesticides.

- Irrigated crop production is a probable source of pollutants such as turbidity, boron, selenium, nutrients, and pesticides. Crop production is concentrated around areas with adequate surface or ground water in Arizona, such as along the Colorado River, the Salt River, the Gila River, and the Verde River.
- Livestock and wildlife grazing are widely distributed throughout the state, occurring on lands owned or managed by federal agencies, Arizona State Land Department, privately owned lands and Indian reservations. Grazing activities may contribute pollutants such as bacteria, nutrients, and suspended sediments (measured as turbidity and SSC).
- Concentrated animal feeding operations (CAFOs) are scattered across the state. These livestock holding areas are a concern due to potential discharges of nutrients, bacteria, and suspended sediment to surface and ground waters.
- Historic use of banned pesticides still causes water quality problems today. Banned pesticides such as DDT take a long time to degrade and bioaccumulate in fish tissue, where they can be passed on to offspring and predators, including humans. It is also possible that these substances are still being used illegally.

Recreation – The high concentration of people in many of the state's popular recreational areas can be a source of water quality impairment. Large numbers of motorized boats can spill a significant quantity of oil and gasoline into lakes. Off-road vehicles can erode sediment into streams. Human and pet waste not properly disposed of can contribute pathogens to the water. Even the feeding of wildlife, such as ducks on our urban lakes, can concentrate these animals in unnaturally high numbers around waterways. As a result, animal waste can reach very high levels in the water.

Urban Runoff – The hard surfaces that cover our state's urban areas can contribute pollutants to Arizona's waters. Roads, sidewalks, and parking lots are impervious surfaces where water cannot permeate the ground. Urban runoff is especially severe during storm events, which can quickly transport pollutants such as sediment from roads or fertilizer from yards into streams and lakes.

Hydrologic Modification – Stream channelization and dam construction are two examples of hydrologic modification in Arizona. These physical alterations can result in water quality problems such as increased sedimentation or excessive nutrient loading due to the removal of "buffer zones" around streams and lakes that would normally filter out pollutants.

A few words about point and nonpoint sources

Water pollution is often discussed in terms of "point" and "nonpoint" sources. Thirty years ago, federal and state regulations primarily governed point source discharges through NPDES permit requirements. Point sources come from a discrete discharge point or discharge pipe (e.g., wastewater treatment plant discharge). However, water pollution also comes from more diffuse sources that are referred to as nonpoint sources, such as runoff from fields, urban areas, or mining operations.

As indicated in **Table 40**, most pollution in Arizona's surface waters is contributed by nonpoint or diffuse sources of pollution. This may indicate the effectiveness of the state and federal regulatory programs working with point source discharges and that control of nonpoint source contributions largely remains non-regulatory, based on education and funding mitigation projects.

Table 40. Point and Nonpoint Source Contribution to Impairment

	Streams, canals, and washes (miles)	**Lakes and reservoirs (acres)**
Point Sources	6	15
Nonpoint Sources	735	6,962

For example, in addressing nonpoint source contributions to an impaired surface water, the TMDL Program works with all interested parties to identify implementation strategies to mitigate the problem. Then ADEQ's Nonpoint Source and Watershed Management Programs work with the local watershed work groups and federal agencies to identify funding sources to implement control strategies. Federal agencies, such as the Forest Service and Bureau of Land Management, address nonpoint source pollution in their management strategies by requiring the implementation of Best Management Practices.

Is the water safe to drink, swim in, and fish from?

Can We Drink the Water? – The quality of water delivered by public water systems is strictly regulated and monitored to ensure that federal and state standards established to protect public health are met. Drinking water advisories are issued by the supplier when monitoring confirms that a drinking water standard has been exceeded. If water is supplied by a public water system, information about the quality can be obtained by contacting the supplier and requesting a consumer confidence report, or by contacting ADEQ's Drinking Water Program at 1-800-234-5677, Extension 771-4624.

When water is supplied by a private water system (i.e., a system serving less than 15 connections and 25 people), it is the user's responsibility to test and protect the quality of their drinking water. General water quality information and ways to protect drinking water sources can be obtained by contacting a county health department. Ground water quality information about wells monitored in an area can also be obtained from EPA's STORET database through the internet at: http://www.epa.gov/STORET

Is It Safe to Swim in the Water? – Frequently visited swimming areas are monitored for *Escherichia coli*, such as at Slide Rock State Park, Lake Havasu, Lake Powell, and the Salt River Recreation Area. Beaches have been closed when verification sampling results exceed water quality standards and remain closed until standards are met. ADEQ is unaware of routine monitoring at other swimming and water-skiing areas. Studies suggest that swimming should be avoided in storm water runoff and in stagnant water. Waters classified as "effluent dependent waters" and many urban lakes are also not designated for swimming or wading uses.

Mohave County monitors beaches regularly in Lake Havasu during the summer. Extensive studies and mitigation actions were conducted in Thompson Bay in the 1990's to correct historic pathogen problems.

The Bureau of Reclamation in cooperation with the National Park Service monitors beaches once a week during the summer in Lake Powell. Lake Powell beach closures have occurred only in Utah.

The US Forest Service monitored the Salt River Recreation Area during the summers of 2002 and 2003 under ADEQ's Water Quality Improvement Grant Program. Monitoring data showed nominal bacterial levels, with no confirmed exceedance which would cause a swimming closure. ADEQ awarded a Water Quality Improvement Grant to improve sanitary conditions in this heavily used recreation area.

Of the monitored swimming areas, only Slide Rock State Park closed for swimming during the assessment period. A bacteria Total Maximum Daily Load (TMDL) analysis has been completed on Oak Creek at Slide Rock State Park, which estimated contributing loads from sources within this sub-watershed and developed alternatives to mitigate impacts to water quality. The following Slide Rock swimming closures occurred during the assessment period:

1998 - 7 closures, occurring June through September
1999 - 10 closures, occurring July through September
2000 - 20 closures, occurring May through September
2001 - 16 closures, occurring June through September
2002 - 3 closures, occurring July through August

Should We Eat the Fish? – Some chemical pollutants concentrate in fish and shellfish by accumulating in fatty tissues or selectively binding to muscle tissue. Some of these pollutants cannot be detected in the water column nor in bottom sediments, but bioaccumulate in aquatic life. This bioaccumulation may pose a threat to human health if these organisms are eaten on a regular basis in excess of federal fish consumption advisory guidelines.

Fish consumption advisories are issued to inform the public about possible adverse health effects and contain recommendations for how many fish meals can safely be consumed. Advisories may be directed at a particular subset of the population because some people are at greater risk (e.g., sport or subsistence fishers, pregnant women and children).

In Arizona, fish consumption advisories are currently in effect in 12 areas **(Table 41 on the next page)**. Additional information about fish tissue screening and fish advisories can be obtained by contacting ADEQ at (602) 771-4536 or Arizona Game and Fish Department at (602) 789-3260.

Table 41. Fish Consumption Advisories – 1998-present

Waterbody Name Size	Pollutant and Sources	Advisory and Date
Painted Rocks Reservoir, Painted Rock Borrow Pit Lake, and portions of the Gila, Salt, and Hassayampa rivers – 380 acres and 140 miles	DDT metabolites, toxaphene, dieldrin, and chlordane pesticide pollutants due to historic use of these banned pesticides.	Since 1991 – Do not consume fish and other aquatic organisms.
Dysart Drain (canal drains to Agua Fria River in the Phoenix metro area) – 3 miles	DDT metabolites contamination caused by historic use of this pesticide.	Since 1995 – Do not consume fish and other aquatic organisms.
Arivaca Lake – 120 acres	Mercury contamination. Potential sources include mine tailings, atmospheric deposition, and naturally mineralized soils.*	Since 1996 – Do not consume fish and other aquatic organisms.
Pena Blanca Lake – 50 acres	Mercury contamination caused by historic mining and natural conditions at the lake.*	Since 1995 – Do not consume fish and other aquatic organisms.
Upper and Lower Lake Mary – 1625 acres combined	Mercury contamination. Sources to be investigated.	Since May 2002 – Do not consume walleye fish and limit consumption of other fish to one 8-ounce fillet per month.
Parker Canyon Lake – 129 acres	Mercury contamination. Sources to be investigated.	Since October 2002 – Women of childbearing age and children under age of 16: No consumption Women not in above categories: Consult health care provider Adult men (16 yrs. or older): Three 8 ounce (uncooked weight) fish meals per month
Lyman Lake – 1500 acres	Mercury contamination. Sources to be investigated	Since October 2002 – Children under the age of 6: No consumption Women of childbearing age and children under the age of 16: One 8 ounce (uncooked weight) fish meal per month Women not in above categories: Consult health care provider Adult men (16 yrs. or older): Five 8 ounce (uncooked weight) fish meals per month
Soldier Lake – 28 acres	Mercury contamination. Sources to be investigated.	Since July 2003 – Do not consume fish.
Soldier Annex Lake – 122 acres	Mercury contamination. Sources to be investigated.	Since July 2003 – Do not consume fish.
Long Lake – 594 acres	Mercury contamination. Sources to be investigated.	Since July 2003 – Do not consume fish.
Alamo Lake - 1,414acres	Mercury contamination. Sources to be investigated.	Since February 2004 - Children under the age of 6: No consumption of largemouth bass or black crappie Women of childbearing age: One 8 ounce (uncooked weight) fish meal per month of largemouth bass or black crappie Women not of childbearing age: Five 8 ounce (uncooked weight) fish meals per month of largemouth bass or black crappie Adult men (16 yrs. or older): Six 8 ounce (uncooked weight) fish meals per month of largemouth bass or black crappie
Coors Lake - 229 acres	Mercury contamination. Sources to be investigated.	Since February 2004 -- Children under the age of 6: No consumption of largemouth bass Women of childbearing age: One 8 ounce (uncooked weight) fish meal per month of largemouth bass Women not of childbearing age: Five 8 ounce (uncooked weight) fish meals per month of largemouth bass Adult men (16 yrs. or older): Six 8 ounce (uncooked weight) fish meals per month of largemouth bass

* Source identification and remediation actions have been developed through the Total Maximum Daily Load (TMDL) analysis process.

ADEQ is investigating opportunities to combine resources from multiple programs to determine the source, transport, and fate of historically used pesticides along the Gila River and its tributaries between Phoenix and Painted Rocks Lake. This study could be used to update the health risk assessment issued in 1991 by the Arizona Department of Health Services and to complete a TMDL analysis for these pesticides.

National Mercury Fish Consumption Advisory – In January 2001, EPA issued a national advisory concerning risks associated with mercury in freshwater fish for women who are pregnant or may become pregnant, nursing mothers, and young children. EPA is recommending that these most vulnerable groups limit fish consumption to one meal per week. That would be six ounces of cooked fish (eight ounces of uncooked fish) for an adult, and two ounces of cooked fish (three ounces uncooked) for a young child. US Food and Drug Administration has a companion advisory concerning the hazard posed by some fish purchased commercially (http://www.cfsan.fda.gov).

Nationally, mercury is thought to be introduced into water at higher than natural background levels due to air deposition. However, the main sources of mercury in Arizona are thought be natural deposits, along with anthropogenic use of mercury. When mercury enters the water, biological processes transform it into the highly toxic form of methylmercury. Methylmercury accumulates in fish, with larger predatory fish generally accumulating higher levels of methylmercury. Methylmercury is a potent toxin, and babies of women who consume large amounts of fish when pregnant are at greater risk for changes in their nervous system that can affect their ability to learn.

Further Investigations – In cooperation with the Arizona Game and Fish Department, ADEQ has been investigating human health risks associated with eating fish caught in Arizona's lakes. Fish tissue samples have been collected and analyzed for mercury from the following lakes, which were chosen due to present or historic mining, the presence of predatory fish (e.g., largemouth bass, channel catfish, or northern pike), and recreational fishing activity:

- Bill Williams Watershed – Alamo Lake
- Colorado/Grand Canyon Watershed – Dogtown Reservoir
- Little Colorado-San Juan Watershed – Ashurst Lake, Fool's Hollow Lake, Lake Mary, Lyman Lake, Mormon Lake
- Middle Gila Watershed – Horsethief Basin Lake, Lynx Lake, Picacho Reservoir
- Santa Cruz-Rio Magdalena-Rio Sonoyta Watershed – Parker Canyon Lake
- Upper Gila Watershed – Dankworth Ponds, Roper Lake
- Verde Watershed – Goldwater Lake, Granite Basin Lake, Pecks Lake, Stoneman Lake, Watson Lake, Willow Creek Reservoir

Results from this monitoring led to the fish consumption advisory issued in May 2002 for Upper and Lower Lake Mary, Parker Canyon Lake and Lyman Lake. Recent monitoring in support of the Lake Mary TMDL has discovered mercury in Soldier Annex, Soldier Lake and Long Lake and also led to advisories for all three of these lakes.

Why do Fish Kills or Abnormalities Occur? – Fish kills investigated by the Arizona Game and Fish Department and found to be due to a water quality concern are reported in **Table 42** on the next page. Most of these fish kills were associated with highly productive (eutrophic or hypereutrophic) lakes. Although lake eutrophication is a natural process, it can be accelerated by human activities in the watershed or lake design. Fish kills caused by a reduction in water quantity (i.e., drought, dam releases) or because non-native game fish have been stocked in habitats that cannot support them, are not reported in **Table 43**.

Lake Sierra Blanca experienced a fish kill in 1998 due to weed growth and high pH. It has been placed on the Planning List for further monitoring.

Table 42. Reported Fish Kills and Abnormalities -- 1998-2002

Surface Water and Size	Pollutant and Sources	Dates
Little Colorado River-San Juan Watershed		
Black Canyon Lake 37 acres AZL15020010-0180	Ash, debris and sediment from the Rodeo-Chediski Fire washing into the lake following monsoon rains resulted in a complete fish kill.	July 2002
Cholla Lake 130 acres AZL15020008-0320	Organic bottom sediments resuspended in the water column by the wind, caused low dissolved oxygen and a massive fish kill	July 2002
Middle Gila Watershed		
Canyon Creek 6 miles AZ15060103-014	Ash washing down the creek following the Rodeo-Chediski Fire killed all fish as well as all other aquatic life. Note that the damage was observed to extend farther downstream into tribal land.	July 2002
Cortez Park Lake 2 acres AZL15060106B-0410	Herbicide applications resulted in a massive die-off of aquatic vegetation. Associated low dissolved oxygen then killed approximately 2600 fish.	June 1999
Grand Canal 5 miles AZ15070102 - 250	Fish kill consisting entirely of carp occurred between 99th and 107th Avenues. Probable cause was dumping of unknown substance into canal.	2001
Salt River, below 91st Ave. WWTP 5 miles AZ15060106B-001D	Inadequate treatment (lack of aeration and denitrophication) due to a power outage, resulted in an extensive fish kill in the Gila River and part of Buckeye Canal.	October 2000
Salt Watershed		
Crescent Lake 100 acres AZL15060101-0420	AGFD reports that due to productivity (algal blooms), winter and summer fish kills have occurred on a very regular basis. The most recent was in 1998.	Winter 1998
Lake Sierra Blanca 30 acres AZL15060101-1390	Aquatic weed growth and subsequent high pH resulted in the death of approximately 100 rainbow trout.	June 1998
Santa Cruz-Rio Magdalena-Rio Sonoyta		
Arivaca Lake 120 acres AZL15050304-008	Algal bloom die off and resulting low dissolved oxygen killed 4000-5000 fish over a 4-day period in 1999. A smaller fish kill in 2000 was related to a storm inflow of water that suspended organic sediment loading in the lake and caused low dissolved oxygen.	June 1999 July 2000
Upper Gila Watershed		
Luna Lake 120 acres AZL15040004-0840	Algal bloom die-off, high pH, and low dissolved oxygen resulted in several hundred fish dying over a 16-day period.	July 1999
Verde Watershed		
Watson Lake 150 acres AZL15060202-1590	A blue-green algae bloom and high pH (9.5 - 9.8) associated with a fish kill. The algae is normally associated with lakes with high pH and elevated nutrients. It can produce a toxin that can kill fish.	July 2000
Whitehorse Lake 40 acres AZL15060202-1630	Low dissolved oxygen due to algal bloom die off, killed approximately 4000 fish. The majority of the dead fish were non-native black crappie young of the year.	July 1999